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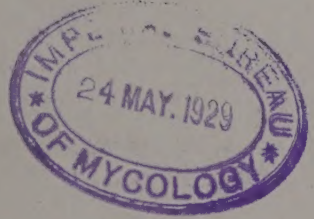
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RASPBERRY DISEASES IN IOWA

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AMES, IOWA

RASPBERRY DISEASES IN IOWA

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The successful production of raspberries in Iowa depends largely on controlling the diseases that affect them. Raspberries are subject to a number of diseases such as leaf spot, orange rust, crown gall, mosaic, leaf curl and also to winter injury. Other diseases affect raspberries, but only those that are known to be serious in Iowa will be discussed.

During the past 10 years many growers have sent inquiries to the experiment station indicating that they were either unaware of the existence of disease in their plantings, or if they did recognize its presence, they did not know how to control it. Furthermore, their lack of proper understanding of the diseases of this crop has often led to the planting of diseased stock. Such cases frequently have meant early failure of the crop. In many cases altho the grower was very skillful in the other cultural aspects of his crop, his inadequacy in combatting diseases has outweighed his skill. This condition shows a clear need for information and has prompted the writing of this circular which is devoted to a description of the symptoms or signs and the control measures of raspberry diseases.

Anthracnose

This disease is caused by a fungus that attacks both red and black raspberries but is serious only on the blacks. All parts of the plant above the ground, including the canes, laterals, leaves and the fruits are attacked.

SYMPTOMS:

Anthracnose infection of raspberry canes and laterals occurs only on the young succulent growth. The first evident signs of infection consist of small, purplish spots. These spots enlarge to one-eighth inch or more in diameter, become oblong, sunken and surrounded by a purple border as illustrated in fig. 1. Later the centers become light gray in color which indicates that spores are being produced in these grayish centers. The spots are frequently so numerous that they run together and partially or completely girdle the cane. Towards the end of the growing season the tissue of the anthracnose lesions becomes dry and splits.

On the foliage, the anthracnose fungus produces small ir-

regular or round spots with a purplish border that are rarely larger than one-sixteenth of an inch across. The tissue in these spots dies and often drops out giving a shot hole effect. These leaf infections occur rather late in the season, and must not be confused with *Septoria* leaf spot, a disease due to a different fungus that causes more serious defoliation than anthracnose, and which occurs in the spring and early summer.

The fruit of raspberries may be injured by anthracnose due to the girdling effect on the canes, laterals and fruit pedicels, or to infections on the berries themselves. If canes, laterals, or fruit pedicels are completely girdled, all berries at their tips die. With partial girdling the berries are injured in proportion to the degree of girdling. The infected drupelets become brown and soon dry up when infection occurs on the berries.

CAUSAL ORGANISM:

The fungus that causes anthracnose of raspberries, *Plectodiscella venetum*, reproduces itself by spores which are borne in the infected areas. These spores are carried to surrounding plants chiefly thru the action of air currents or spattering of rain. In favorable moisture conditions the spores germinate and penetrate into the host tissue causing new infections. The anthracnose organism produces two kinds of spores as illustrated in fig. 2. One of these spores is borne in the early spring and the other thruout the remainder of the growing season. The early spring spore form (known as an ascospore) is produced from the old lesions or spots on the last season's canes. These ascospores in the spring cause the initial infections which later produce the second spore form, or summer spore. A number of generations of the summer spore form may develop during a season and thus increase the amount of infection. While active growth of the fungus stops when the plant becomes dormant the fungus does not die, but lives in the old lesions until spring when the ascospore stage is again produced.

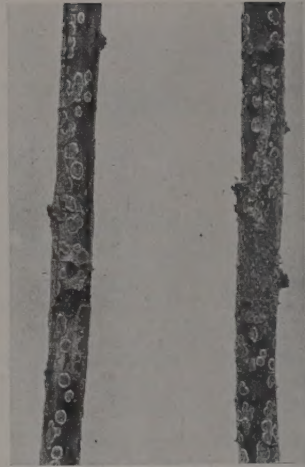


Fig. 1. Anthracnose on black raspberry canes. Note the ash gray spots in the bark. Such injuries very materially interfere with the normal growth of the canes, and cause them to become stunted, seriously weakened and susceptible to winter injury. Such canes should be pruned out in the spring before the plants become active.

CONTROL:

New plantings should be removed as far as possible from old plantings. In setting out new plants the canes should be cut back below the surface of the soil.

The tips which are planted should be removed from the old plantation, while still dormant and before the new growth is exposed to infection.

The proper cultural practices and spraying will hold anthracnose in check if it is already present in the plantation. Old canes should be removed from the plantation and burned as soon after harvest as practicable. Before spring the producing canes for next summer's crop should be thinned to the required number, taking out the most severely infected ones. Proper ventilation surrounding the raspberry plants is of great importance in the control of anthracnose. In a dense growth of vegetation the humidity is comparatively high and this condition is very favorable for the infection of the plants. Weeds should not be allowed to grow.

In general for the control of the anthracnose disease, two applications of lime sulfur spray are recommended as follows:

(1) The first application should be made in the early spring just before the leaf buds open. Make this spray by diluting 1 gallon of commercial lime sulfur with 20 gallons of water. This spray should be applied every year even tho there is only a small amount of anthracnose.

(2) The second application should be made when the young shoots are 8 to 10 inches high. This spray is made by diluting 1 gallon of commercial lime sulfur with 40 gallons of water.*

It is very important that every cane should be thoroly covered with the lime sulfur solution.

*In our experimental work it has also happened that a third spray, applied when the fruit was half grown gave very beneficial effects. In 1926, the third spray caused some foliage burning due doubtless to the very hot, dry weather just after it was applied. As a rule, however, burning with the third spray does not occur. It has only been experienced once in six seasons.

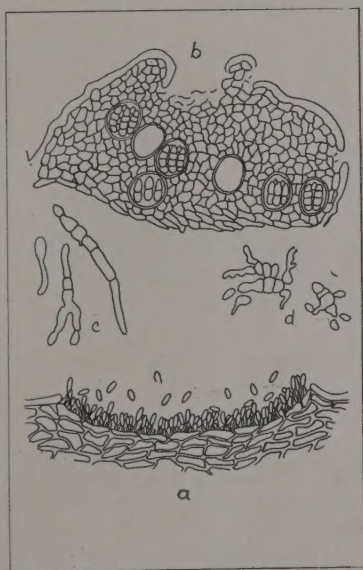


Fig. 2. The anthracnose fungus which attacks raspberries. (a) Summer spore stage; (b) early spring stage (after Burkholder); (c) showing germination of summer spore (after Burkholder); (d) germination of winter spore (after Jones).

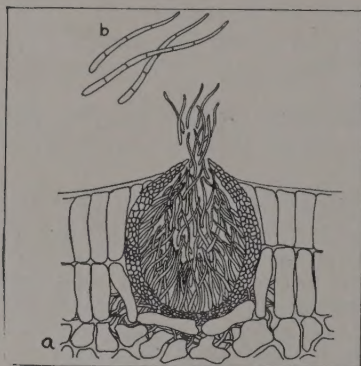


Fig. 3. Septoria leaf spot magnified. (a) Showing the fruiting structure of the fungus in the leaf tissue; (b) spores.

Septoria Leaf Spot

Septoria leaf spot is a very common disease on both red and black raspberries. Although generally present, it is not regarded as serious except in certain seasons when partial defoliation of the raspberry plants results from its attack.

SYMPTOMS:

The fungus causing Septoria leaf spot attacks the leaves chiefly, but the canes may also be affected. Infections on the canes do not penetrate deeply into the

bark and are not considered very serious to the plant. Infections on the leaves first appear as very small circular purple spots which enlarge but rarely become larger than one-fourth inch in diameter. The centers of the spots are killed and become an ashen gray color. The fungus soon produces fruiting bodies within the gray centers; these bodies appear as minute black dots.

Leaf spot caused by Septoria is frequently mistaken for anthracnose leaf infection. The spot caused by Septoria occurs early, whereas anthracnose leaf infection usually occurs late in the growing season. The spots caused by Septoria are quite circular in outline while anthracnose spots are irregular. In general, defoliation is more serious from Septoria leaf spot than from anthracnose.

CAUSAL ORGANISM:

Septoria leaf spot is caused by the fungus *Mycosphaerella rubi*. The spores produced in the infected leaf areas, fig. 3, during the spring and summer are liberated and transported to surrounding leaves by air currents, rain and other agencies. Under favorable conditions of moisture the spores germinate, the fungus penetrates into the leaves and new spots result. During the growing season numerous generations of the Septoria spores may be produced. The fungus remains alive in the old infected leaves during the winter. In the spring a second type of spore (known as an ascospore) is produced and discharged. The spores borne in the spring produce the initial infections on the new crop of leaves.

CONTROL:

As a general rule, spraying only for the control of Septoria leaf spot is not recommended. It has been found that the two ap-

plications of lime sulfur recommended for the control of anthracnose also prevent *Septoria* leaf spot. In seasons very favorable for this fungus, defoliation may become severe and applications of lime sulfur should be made as a preventative against *Septoria* leaf spot as well as against the anthracnose disease.

Orange Rust

Black raspberries, blackberries* and dewberries are subject to a fungus disease known as orange rust, but the red raspberry is highly resistant. Plants may remain alive for several years after they become infected but are very weak and unproductive.

SYMPTOMS:

Orange rust lives within infected plants from year to year. Such plants produce weak spindling shoots with small, pale green leaves. Two or three weeks after the leaves open they become covered on the under side with light colored blisters, which break open and discharge dusty masses of orange colored spores. These spores are produced for three or four weeks, after which time no more develop until the following spring. They cause local, rather inconspicuous infections on the leaves in the spring, or early summer. These leaf infections produce a second type of sport termed "teleutospore." The teleutospores mature at the time the tips of the canes are becoming rooted and cause the infection of the new tips. Such tips do not show any outward signs of infection during the re-

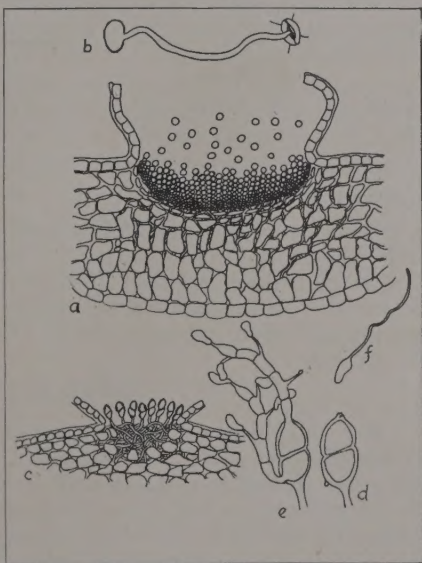


Fig. 4. Orange rust of raspberry. (a) Orange rust pustule on raspberry leaf. Note escaping spores; (b) germinating caecoma spore; (c) teleutospore pustule on surface of leaf; (d) teleutospore; (e) germinating teleutospore.

* Blackberries, in addition to being susceptible to the rust fungus that attacks raspberries, are susceptible to a second form of orange rust. This second form is very similar in appearance but does not affect raspberries. Frequently raspberries are found rust free altho growing in close proximity to rusted blackberries. Such instances do not indicate that the raspberries are not susceptible to orange rust but indicate that the form of rust which is non-pathogenic to the raspberry is present on the blackberry.

mainder of the season, but produce spindling shoots and rusted leaves the following spring. They are systematically infected; that is, the disease is present thruout their roots and crown. Such plants produce only diseased shoots as long as they live.

Infections with teleutospores may also result on shoots from old plants that are produced late in the season and by this means a portion of the plants that were healthy when planted may become systemically infected. Plants are occasionally found where rust is not present on all of the canes. These plants were infected when 1 year old or older thru shoots produced late in the season.

CAUSAL ORGANISM:

Orange rust, caused by the fungus, *Gymnoconia interstitialis*, as illustrated in fig. 4, produces two kinds of spores. One of these is the orange rust spore which is so conspicuous on infected plants in the spring and the other is the dark brown teleutospore which is produced during August or September. The two types of spores cause different kinds of infections. The orange colored spores produce local infections on the leaves. The teleutospores, on the other hand, produce general infection of the plant. The fungus lives over winter within the tissue of the infected raspberry plant. In the spring the new growth, including the leaves, is invaded by the rust fungus present within the canes and another crop of the orange rust spores is borne on these leaves.

CONTROL:

Plants affected with orange rust remain infected as long as they live and should be completely removed as soon as discovered. Rusted plants are not only non-productive but are a constant menace to the entire plantation. Affected plants should be dug up and burned before the orange colored spores are disseminated in the spring.

Crown Gall

Red and black raspberries are frequently affected with a very serious disease known as crown gall which is caused by a bacterium. The disease is common both in nurseries and in the field. Plants affected in the nursery are unsaleable and nurserymen frequently discard as high as 20 percent of their plants because of this disease. In the plantation infected plants are unproductive and as the disease becomes generally established, as it frequently does, the entire plantation must be plowed up.

SYMPTOMS:

Crown gall infection occurs most commonly on the crowns and roots of the plants, altho galls may also occur on the canes. The bacteria, which are generally present in the soil of infested

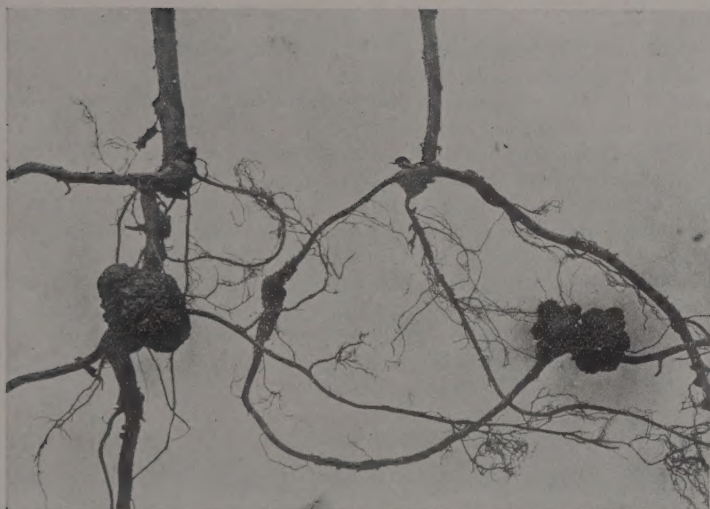


Fig. 5. Crown gall on roots of red raspberry. Such swellings as these may occur also at the crown or on the canes above ground. These galls interfere with the normal growth of the plant, leading frequently to stunting or even killing of the bushes.

fields, gain entrance thru injuries caused by cultural operations, weather and other agencies. At points where infection occurs, galls are formed varying in size from one-fourth inch to over one inch in diameter, fig. 5. These galls are at first soft and spongy and are light yellow in color. Irregularities on the surface are not marked in young galls, but as they increase in size the surface becomes irregular and dark brown in color. Old galls have rough, dark surfaces and become brittle. Galls on infected plants further contaminate the soil with the crown gall bacteria. These bacteria are distributed to the surrounding areas thru surface drainage and by cultivation.

This disease leads to dwarfing and dying of the canes. The galls interfere with the normal passage of sap in the canes. Plants weakened by crown gall infection are more subject to winter injury than are healthy ones.

CAUSAL ORGANISM:

The organism that causes crown gall is a bacterium, *Pseudomonas tumefaciens*. This organism is a microscopic one-celled plant that attacks many species of plants in addition to raspberries. At the points where infection takes place the bacteria multiply rapidly by the simple division of a bacterium into two. Hence in a short time they become very numerous.

CONTROL:

The only effective way known to check crown gall is to use healthy plants transplanted into soil that is not infested. It is not possible to save plants after they have once become infected. No form of spraying is of any value.

In starting a plantation great care should be taken to select plants that do not have swellings on any portion of the plant. Plants should be obtained from a source where the parent plants are known to be free from this disease. In setting out a new raspberry plantation a field should be chosen where no berries, apple, or peach trees have grown for several years. Apple and peach trees, as well as raspberries, are subject to the crown gall disease. It is known that the crown gall bacteria live in the soil for months. Certain perennial weeds, such as sour dock,* are susceptible to the crown gall disease.

Mosaic Disease

Among the most serious diseases of animals and plants are the maladies known as virus diseases. Yellow fever, diphtheria and smallpox of man, and hog cholera and foot and mouth disease of animals are examples of the virus disease group. In the plant kingdom many species are subject to virus diseases. Raspberries are susceptible to a number of different virus maladies among which mosaic and leaf curl are the most serious.

The causal agent for mosaic and leaf curl of raspberries, or for other virus diseases of plants and animals, is not known. It is known, however, that these diseases are very infectious and that infection depends on the transfer of an infinitesimally small amount of the juice from an infected to a healthy plant. The disease becomes general, that is distributed thruout the roots and above ground parts. A plant once infected remains infected thruout its life.

The mosaic disease is extremely infectious and often spreads with great rapidity from single infected plants to surrounding plants. Transmission is dependent on plant lice and possibly on other insects. The insects in feeding carry the causal agent of mosaic from diseased to healthy plants. As far as known all varieties of red, purple and black raspberries are susceptible. It has been found that the disease affecting the red and purple varieties can be transmitted to black raspberries. Recent investigations indicate that black raspberries are also, in addition, affected with at least two other mosaics. It is not known whether all of these occur in Iowa. The description of symptoms given refers to the condition that has been noticed on infected plants in this state.

*Unpublished data.

SYMPTOMS ON RED AND PURPLE RASPBERRIES:

Plants affected with mosaic have a general yellowish, sickly, appearance. They are more or less stunted depending on how long the disease has been present in the plants. A characteristic symptom is the mottling effect on the leaves. The leaves in general become yellow and are later differentiated into regular areas of yellowish green and dark green. While the mottling may consist only of an irregular pattern of small, dark green and yellowish-green areas, the dark green areas are often of considerable size and are raised above the surface of the leaf into irregular shaped blisters surrounded by the light yellow portions of the leaf. Leaves with the raised dark green blisters curl downward at the margins. On the leaves of the fruiting canes mottling and blisters appear, but as a rule the symptoms here are less pronounced than on the leaves of the young shoots.

The mottling symptoms on mosaic infected plants are most pronounced during the spring on the younger leaves near the tips of the canes. Later in the season, during hot dry weather, the symptoms become less evident and the mottling may entirely disappear. When a period of cool weather occurs in the summer, the mottling symptoms on the new leaves reoccur.

The canes of mosaic infected plants are shorter and more spindling than are those of healthy plants. Especially is this true where the plants have been infected for one or more years. Leaves smaller than normal are produced on such plants. The stunting due to mosaic is slight the first season, but becomes progressively more serious in succeeding years. Many of the plants in mosaic infected raspberry plantations die and within a few years, many hills are missing. This dying of the plant is at least indirectly attributable to mosaic. While a mosaic infected plant may live for years, such plants are weakened and are more subject to winter killing and to unfavorable growing conditions.

SYMPTOMS ON BLACK RASPBERRIES:

The general effect of mosaic on black raspberries is a mottling of the leaves, stunting, reduced yield and a shortening of the life of the plants. On the leaves the disease causes an irregular mottling of small dark green and yellowish-green areas. The leaf may curl more or less and frequently is abnormal in shape. Black raspberry leaves usually do not exhibit the blister-like raised areas that are characteristic on the red raspberry. Here again the mottling symptoms are most pronounced in cool weather on the leaves near the tips of the canes. During hot dry weather this mottling disappears but may reappear during cool periods. Affected plants exhibit a lack of vigor and their leaves are smaller than normal. Stunting may not be noticeable during the year in which a plant becomes infected, but this effect be-

comes progressively more serious in the following seasons. Infected plants yield less and produce fruits of poor quality, particularly when they have been diseased for a year or more. Where mosaic is prevalent the plants gradually die out or become so unproductive that the planting becomes worthless.

Leaf Curl Disease

Leaf curl is most commonly found on red raspberries altho black raspberries are also susceptible to this disease. It is very destructive and affected plants are rendered worthless in a short time.

SYMPTOMS ON RED RASPBERRIES:

In general the symptoms of leaf curl on red raspberries are curling of the leaves, production of dry seedy fruit and dwarfing of the entire plant. A plant infected with the disease produces dwarfed leaves that have arched veins, and which curl downward at the tips and along the margins. The whole plant becomes stunted more and more severely in succeeding years until the new stems grow to a height of only a few inches. It appears that the portions between the veins of the leaves require more space and the leaf blade consequently has a puckered appearance. In plants that are newly affected, stunting is not apparent. In such plants the symptoms consist of the leaves exhibiting a definite downward curling of the tips and margins as illustrated in fig. 6. In succeeding years the dwarfing of the leaves becomes very severe. The texture of the leaf blade is harsh and brittle. Mottling of the leaves has never been observed. In this respect it is readily distinguished from mosaic. The leaf curl disease produces abnormalities in the color of infected plants. Shoots of plants that have been infected for a year or more are yellowish when they first emerge from the ground but later the leaves become an abnormally dark green color. In matured leaves the veins are darker green than the portions of the leaf between the veins. The fruits produced by plants affected with leaf curl are usually dry, hard and undesirable.

SYMPTOMS ON BLACK RASPBERRIES:

The symptoms on black raspberries are very similar to those on the red varieties. The curling of the leaves is marked and dwarfing becomes progressively more serious in succeeding years. The fruit produced on severely infected plants is small and seedy. Rooting at the tips of the canes may take place in plants that are newly infected but the plants soon lose the power to produce rooted tips.



Fig. 6. This is the leaf curl disease of red raspberries. The cane on the left is a healthy cane. Note the small leaves with turned down margins. Such leaves are frequently darker, harder and more brittle.

CONTROL OF MOSAIC AND LEAF CURL:

Raspberry plants affected with mosaic or leaf curl cannot be cured. Infected plants remain so thruout their life even tho symptoms may be absent during certain periods. In order to control the virus diseases it is necessary that the plants be prevented from becoming infected.

In setting out a new raspberry plantation all possible precaution should be taken to plant stock that is free from the virus diseases. Some nurseries are now selling raspberry plants certified to be free from virus diseases. However absolute free-

dom from these diseases cannot as a rule be guaranteed. It is also true that uncertified stock may contain a very high percentage of mosaic infected plants. Such being the case it is best to use certified stock for starting a plantation.

After a planting has been started, constant watch should be kept to detect any plants that are infected. When such plants are found they should be destroyed. In the case of red raspberries which often produce shoots at some distance from the hill constant watch should be kept that none of these are allowed to grow. When an infected plant is found the surrounding plants within a radius of six feet should also be removed because the aphids from the diseased plants may have migrated to and infected these adjoining plants. Before digging and removing infected plants from the field the aphids on them should be killed. This precaution is very important to prevent spreading the disease bearing aphids while the plants are being carried out of the plantation. Fire, as for example a kerosene torch, spraying with kerosene or black leaf 40 or dusting with nicotine sulphate dust are suggested as means of killing the aphids. The removal of infected plants is recommended only where the percentage of infection is not over 10 percent. In plantations where the disease is more prevalent the planting may be allowed to grow until it becomes unprofitable when it should be destroyed.

Absolute control of aphids in the raspberry plantation theoretically should be effective in preventing the spread of virus diseases; however, this is impracticable. It is practical for growers to plant disease free stock at some distances from other possibly infected raspberry plantings and to remove infected plants as soon as they are found. A new plant may safely be set where an infected one was removed as soon as it is certain that the removal was complete.

Winter Injury

Winter injury on raspberries consists of the canes being partially or wholly killed some time after the plants have stopped growth in the fall. The tips of the canes are usually affected first, because this portion of the cane is the youngest wood. The extent of the winter injury is probably dependent on two factors, first the state of maturity of the canes, and second, the degree of fluctuation of the temperature. If the plants go into winter with a large amount of soft young wood the amount of injury is much greater than where the wood has had time to mature. Since the wood that is designed to bear the fruit is nearest the tip of the cane, it frequently happens that winter injury is responsible for crop failures.



Fig. 7. Winter injury on red raspberry, spring 1927. Note canes dead to the ground and new shoots growing from the roots. Clean cultivation during summer and straw mulch applied in fall 1926.

Such dead or injured wood affords a splendid point of entrance for wound parasites which continue the destruction of the living wood. Thus we often find the disease called cane blight, *Coniothyrium fuckelii*, which occurs as a follower of winter injury thruout Iowa.

CONTROL:

The most practical way of preventing winter injury that has been observed is to lay down the canes in the fall and cover them with dirt. This may be done with a spade or by throwing two furrows together, thus burying the canes in a ridge just over the crowns of the plants. This practice has been observed to effectively prevent winter injury. If this practice cannot be followed, then every effort should be made to bring the plants into the winter condition with the minimum amount of immature wood. The crowns may be protected with straw or manure as soon as the ground freezes.

